ARCHITECTURAL COMPOSITION.

DIVISION III. DESIGN OF THE BUILDING.

By Professor Heinrich Wagner.

83. General.

It was shown in Division I that external form must be based on internal organism of the building, that both may have the most intimate relation to each other. In the primary ideas of the design, they cannot be separated. When the artist represents his idea, he must mentally see the principal lines of the entire structure. With this general image in mind, he makes the drawing board the work shop of his mind, where he sketches in its main lines the design of the building in plan and elevation, afterwards embodying it in the completed project. The floor plans determine the form and the internal subdivision of the building; they supplement the views, elevations, and sections, which exhibit the external and internal architecture, and the construction in part. The preceding Division contains the principles controlling the design of the building, which manifest themselves in the organic arrangement and the connection of its separate parts. The points of view for considering the general design, on which is based its leading features, are now to be stated.

Chapter 1. Data for Design.

84. Programme.

The purpose and importance of the building determine the general and space requirements. These must be first considered, the number of rooms and their dimensions be fixed, and choice made of site for the building. A statement of special local needs and of personal requirements must also precede designing the structure. To these data are added limitations of money for building, frequently the mode of construction and finishing, legal and statutory requirements, etc. All such conditions are usually comprised in a programme and form the primary data of the design.

It is necessary to obtain a clear idea of all points to be considered before commencing. This can very seldom be obtained from the programme alone, which is generally defective, though the success of the work greatly depends upon this. Responsibility for the building always rests on the architect, and he recieves the blame if it be a failure. He should therefore endeavor to take part in preparing the programme. But he must obtain clear knowledge of the conditions, so that he may point out disadvantageous things and improve the requirements; he should properly guard himself from consequences to be feared. His resignation will only be tentered when the requirements of the programme cannot at all be harmonized

with a rational design for the structure. Even if the building be primarily adapted to its purpose, it must also be arranged in accordance with the wishes of those who are to occupy or own it. The owner pays for the building, and therefore attention is to be paid to his wishes and decisions. The skill of the experienced architect will usually succeed in properly solving the difficulties in some manner, if his influence be not sufficient to remove them entirely. These factors influencing the programme can be given only for the different kinds of buildings, and then merely according to circumstances. These requirements are as defective if too vague as for them to be too rigidly stated. The assistance of an intelligent architect is therefore indispensable in arranging the program.

85. Space Requirements.

Space requirements of the problem are usually incorrectly fixed. They are often underrated as over estimated. The owner usually lacks judgement even if perfectly acquainted by experience with the needs the building is to fulfil. Persons with little knowledge of the profession may be able to understand a drawing, but only in using the completed building will its faults appear, and the owner then discovers that the rooms are too large or too small, though their number and dimensions were prescribed by him, and that their sequence and arrangement do not correspond to the conditions of the problem, nor to his own expectations and wishes. These requirements are chiefly fixed by the purpose to be served. They further depend on the money available, assuming it to be a good and economical design. Their influence on the programme is therefore of great importance.

86. Site of Building.

Difficulties in the choice of a site are often not properly considered, even if the question of suitability for the purpose be more easily decided than many other conditions. Yet the necessary dimensions are often under-estimated. The duty of an expert is to examine the proposed building site in general and in detail, and in accordance with its location, nature, area and dimensions, to consider the possibility of giving the building a fit location, of enlarging it if required, of obtaining good lighting and free access of air, as well as for fulfilling other needs of the occupants for health, well-being, and comfort. Those questions are often of such importance that they decide the choice of site. But for other buildings, the point of view may be of an esthetic nature, requiring from the artistic stand-point that the external architecture may produce a striking, graceful or monumental effect.

Other questions are not technical, concern the suitability of the building, but are only indicated here. First are convenient roads for access to the grounds, connection with streets and waterways, and secondly is the opening of the building to business, to the life and traffic of a great city, making it of as easy access as possible, and thirdly, to separate it far from noise and manufactories, from bustle and disturbances of all kinds.

87. Local Influences.

First is an examination of the site in reference to its nature, low or high situation, existence of water in the ground and possibility of inundation, which will decide the grade for the building or its lower story, and other precautions to be taken against water and dampness, and the means to be adopted for drainage. Lack of water must often be remedied. In low ground one must beware of marshy earth, of fog and stagnant air, while on hills and on the sea shore, the effects of prevailing winds must be guarded against. The possibility of a sinking of the earth and of earthquakes must also be considered.

88. Place and Apect of Building.

Location and aspect of the structure partly depend on these, partly on the outlook and surroundings, as well as on orientation for the building or some of its parts. This point will be fully treated for certain kinds of buildings, but is here mentioned in general. An eastern or southeastern outlook is most favorable, just as western and southwestern exposures are unsuitable. To directly southern outlook, although generally healthy, it is objected that during summer one must suffer from heat of the sun, while directly northern exposure is to be avoided for lack of sunshine, though sometimes desirable. The nature and form of the site, course of streets and adjacent buildings, and other local conditions usually prevent the location of the building as otherwise preferable. Even where one has a free hand, it would often be best to take into account various preferences and considerations by not facing the building exactly to the chief points of the compass, but making such deviation as to make climatic influences less prominent.

89. ARtistic Treatment.

The degree of artistic treatment to be given to external appearance and to internal finish of the building depends on its purpose and rank, then upon the many at command. For the first, the principles of treatment in Division I must direct and guide. Consideration of what is most suitable and effective for works of monumental architecture, for ecclesiastical or secular purposes, or for merely useful buiodings for public or private

purposes, must be left to the judgement and imagination of the architect. Directions of this kind, afterwards usually included in the programme, may be stated only in a very general way with reference to money available, and serve as an approximate limit for the amount of artistic treatment. That design will be best, which produces most with the smallest cost.

If available funds are limited, one shall not cramp the space of the building, but rather limit architectural treatment by avoiding everything unusual. Customary local ideas are almost invariably cheapest. Therefore the building material in the vicinity, so far as suitable for the building, is generally preferable, and it was already stated in Division I that skilful use of this building material and a truthful treatment of it produces a better and more beautiful effect than a more lavish expenditure of costly material without real artistic knowledge. Therefore, even where funds are amply provided, and where one has the good fortune to be intrusted with a work of monumental architecture, it would be well to exercise wise moderation and to be mindful of the principle, that richness must be joined with simplicity, light with shade, animation with repose, and that where the heart rejoices must be not magnificence, but harmony.

90. Fixing Cost of Building.

The chief factors that fix expenditure are the volume of space required and the degree of artistic treatment. These appear clearly in the design and afterwards in the estimate of cost. In order to first compute the sum required for the building, buildings of similar kind and execution, recently erected under like circumstances, may be taken as a basis, and assuming equal heights from these may be deduced the unit of cost per square foot of ground area of the building, or the cost of a building of one, two or more stories; or more correctly, the cost per cubic foot of the total volume of the building may be similarly found. It is not so much the ground area covered by the building, but rather the area that may be utilized for the special purpose of the building, after deducting walls, passages, stairways, etc., that should be made the basis of the unit price for comparing the cost of buildings. This comparison has been made for buildings of the same kind and we find a very considerable difference in cost per square or cubic foot of useful space to occur, according to whether the arrangement of plan of the building is more or less good and compact, independently of other conditions affecting the cost.

But it should not be understood that dimensions of important and necessary ante rooms and corridors or thickness of walls should be reduced;

the former are so increased in many forms of ground plans for buildings as to inconvenience communication in the building, without producing the effect of space, to be attained by their simple and centralized arrangement. This also gradually causes greater extension of the facade and frequently projecting architectural masses which increase the cost. The increase here mentioned is often greater than that for better development in form and richer architectural subdivision of the structure. Much ado is made about the latter, because external and therefore visible to everyone. Nothing is said of waste in arrangement and connection of rooms and of parts of the building, this defect being connected with the inner organism and therefore not apparent. These points will be considered by basing cost of the building on the unit of useful space as indicated. The same end may be simply attained in many cases by computing the unit price according to number of persons accommodated in the building, as in churches, schools, hospitals, etc., by computing the cost per sitting, per bed, etc. This method may also be employed for other units of use.

91. Calculation of Cost.

But a more accurate statement of cost of the building, with a possibility of increase or reduction, is by the careful calculation of cost after the design has been completed. Nothing has so often brought the architectural profession into such discredit with the public as exceeding the estimated cost of the building. This has produced the result that architeotrual works usually taken from the architect and transferred to contractors, sometimes for a lump sum, or by measurement at fixed prices. The owner believes that the cost of preparing the design will be saved, that of supervision by the architect during erection, and that he will also have security against any excess in cost. Yet this is generally caused by the owner himself, either because he forms correct ideas only during the construction, changes his views, and permits changes from the original plans; or seized by a love of building, he allows enlargements, better construction, or greater richness of external or internal architecture, than had been expected. When he comes to payment and final settlement, he is dissatisfied, and all blame is thrown upon the architect. The latter should therefore be careful, when changes are made, to protect himself in good time against reproach for exceeding cost and from damages for his responsibility, by repeatedly and in writing notifying the owner of the additional cost for these changes from the original design.

The architectural profession in Germany here finds itself in a more difficult position than in other countries. Nowhere else are its duties so onerous or the demands of its responsibility so great, and yet nowhere

else is its position so uncertain, its influence so limited. This is partly due to two things, connected with the usual method of estimating and contracting:-

1. The German architect is generally required to compute the quantities and the estimate of cost of the building, required before letting the work to the contractor.

2. The architect and contractor are usually the same person, an academically trained architect becoming a contractor, or an artistically gifted contractor being also a practicing architect.

The first case may have results of a most serious kind, as shown by cases in which architects have become actually liable by exceeding their preliminary estimates. If the custom is once established for the architect to prepare the estimate of the cost, a moral duty is laid on him to keep within it, and he must lessen the risk by taking the execution into his own hands. It is certainly true that the confidential relation then ends, which the architect should have as professional agent of the owner, and for the good of the entire profession this is most strongly to be deplored.

The position of the architect becomes perfectly clear and independent, and his authority greater and more important, if he does prepare the quantities and the estimate of the cost as is the case in England and partly in France. In England the first is made by the architectural surveyor, the last being prepared by the builder; similar functions being performed in France by the architecte-verificateur and the entrepreneur. As their basis and for letting the contract, in England, a specification or accurate description of the work is added to the plans and prepared by the architect, who has to see that this is strictly carried out during his supervision of the work. His duties are otherwise the same, but his services are exclusively devoted to his employer. The functions of the contractor and of the architect are not united, being considered incompatible with the authority of the architect. Interest in any building contract is condemned in the strongest manner by the entire architectural profession, and preparation of the quantities by the architect or his partners is objected to, at least in cities.

No prospect now exists in Germany, that we may attain to the fortunate position of our English colleagues. Yet they are just as strictly held to their specifications and to the contract, as we are to our estimate of cost. Variations from drawings are never to be entirely avoided; for in new buildings, and even more in alterations of buildings, unforeseen things occur; improvements are suggested,not to be rejected without de-

triment, and every such change causes an increase of cost. It is therefore advisable to suggest to the owner to reserve a certain amount therefor, about ten per cent of the cost of the building, independent of any addition to the estimate.

Within limits fixed in this way, it is possible to keep within the estimated cost, exceptigg under very unusual conditions. Even with the present system of estimating, this will result in assuring to the architectural profession its just claim to make the design and supervise the construction, but will also furnish a systematio and fixed basis for its natural position as confidential agent of the owner. Its importance in the state and community would thereby be increased, and its independence become indisputable. The owner would recognize that he would always do better to entrust his building to a skilful and experienced architect, than to transfer it to the master builder. He would understand that the work would thereby gain in design and artistic treatment and in execution, by the architect's supervision of the materials and workmanship, as well as security against claims for extras. These advantages and the security of the owner, who knows that his interests are assured, abundantly compensate for commission paid to the architect.

Chapter 2. Treatment of Rooms.

92. General.

To produce an enclosed room is generally the aim in erecting a building. We therefore commence with the single room as the simplest form of the building. This is also to be regarded as the cell of the architectural organism, as the element which forms a basis for the shape of the building. The use of the room and of the building are not here considered, but only its architectural form, as it appears in the design. The room is partly formed by space-enclosing and partly by space-dividing structural parts. The space-enclosing parts are the roof and the external walls, the space-dividing parts being the floor and ceiling, the division and middle walls, the latter usually parallel to the principal external wall, to which the former are generally perpendicular. Floors and ceilings subdivide the building into different stories.

This frequently requires a space to be merely enclosed, or sometimes covered, otherwise being as open as possible; sometimes a hall must be of such extent that ceiling and roof require intermediate supports between its walls, such as isolated pillars, piers or columns. Colonnades or arcades are also employed to sundivide space. The ceiling, roof, and walls are seldom unbroken; for a connection with the exterior or with rooms above or below, openings are arranged, generally so that they can be clos-

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ed as desired. We have to treat of these parts of the building only so fat as upon their respective places and locations may depend the treatment of the space and the treatment of the building.

a. The Room.

93. Its General Form.

In the treatment of the room, we have first to consider its form in general, with reference to factors influencing this, and whether it is to be considered as an isolated or a space-forming element of the building. This form primarily depends on the intended use of the room, then on the possibility of easily combining it with rooms of similar form with due regard to shape of the building, and lastly upon the money available and on the results of its shape.

94. The Elementary Form.

The rectangular form possesses most advantages in all respects. Regarded from a purely mathematical standpoint, the circle among all figures, and the square among all rectangular figures, are those most compact, or those requiring least wall surface to enclose a given area. This advantage is only theoretical, since disadvantages generally result and neutralize it. The perimeter of the circle is about 11 per cent less than that of the square, therefore materially less. But circular rooms cannot be directly connected. The construction and the details of windows and doors are less simple; all furniture and furnishing must be made to order at increased cost. With a alrge radius, these difficulties are lessened or or removed by the slight curvature, but with a small radius, they are increased and the circular type of plan is exceptional for small rooms. The approximate form of a regular polygon also has many difficulties in combination and construction on account of numerous angles and deflections.

The rectangle makes everything more simple and natural in construction and arrangement; it is therefore the usual and preferred elementary form of a room as a building unit or separate element of the building. (Fig. 93). Oblique angled rooms cannot be avoided when the site is of irregular form, and if variation from the rectangle be not great, it then becomes scarcely noticeable (Fig. 94). It sometimes occurs that even with rectangular ground plan, as on sites at angles of streets, it is permissible to arrange the plan about an axis oblique to the external walls, changing a rectangular room into one partially oblique (Fig. 95). To transform a slightly oblique room into a rectangular one, if the irregularity must not appear, the solution in Figs. 96 and 97 may serve; but such arrangements are not applicable to ordinary plans on account of the considerable expense thereby incurred. If the variation from the right angle

be considerable, the obliquity is to be limited as far as possible to subordinate rooms, or by interposing suitable forms, a regular and pleasing treatment may be obtained (Figs. 98 to 101).

It is still to be considered, when the square is to be preferred to the rectangle. Economy of wall surface will not decide, for if the rectangle does not differ very much from a square, the saving will be slight, scarcely 1 per cent difference for a rectangle having proportions of 3 to 4.

Therefore difficulties in the design of the ground plan are not created, where advantages do not result, everything being taken into consideration. The square form will be preferred, for a tower, (Fig. 102), where no reason exists for giving to room different dimensions on transverse and on principal axes, but suggesting the same treatment in both directions. Figs. 103, 104 are examples. In these and many other cases, the regular polygon or circle is preferred, or ground forms composed of portions of these figures, whether intended for special purposes, as for audience rooms of theatres, circus buildings, etc., for a centrally located room, or for one emphasized in some other way on the plan, or for convenient use of an acute or obtuse angle, an angular and unsymmetrical portion of the plan is actually preferable. The elliptical form is exceptionally found and may be replaced by an approximate figure composed of arcs of circles, or of one extended by straight lines.

The arrangements first described are represented in Figs. 105 to 109. By Figs. 105 and 106 an idea of the external appearance will easily be formed, creating a conviction that by solutions derived from the most important conditions of the problem, a characteristic effect may be obtained, a transition pleasing to the eye, and a combination of the masses of the building and of the members, which would otherwise be awkwardly connected together. Figs. 107 to 109 exhibit rooms enclosed by arcs of circles.

95. Extension of Rooms.

For extension of rooms or annexes, apses, galleries, exedra, angle bays, balconies, loggias, porticoes, grottoes, etc., which must be considered as accessories and always have a special purpose, another type of form is quite appropriate, as in Figs. 110 to 117, whose effect is increased by contrast with the ordinary form. But for simple and frequently repeated rooms, the use of unusual forms is unjustifiable. These should not owe their origin to mere whim or a desire of notoriety. Therefore the fanciful ground forms so commonly employed in the last century (amusement buildings, villas, etc.) should not be imitated, however skilfully they may be combined.

96. Forms of Ceiling.

The form of ceiling depends on its treatment, and the following cases are especially to be distinguished.

1. The roof at the same time forms the ceiling of the rooms; it is then space-enclosing or may be space-dividing, when an upper room exists.

2. The ceiling extends free over the entire room, or intermediate supports may be arranged between the walls.

To these two motives, and the method of construction connected therewith, are to be referred the most varied forms of ceilings, which partly assume plane or curved forms, are partly inclined with uniform or broken slope, or partly of simple or compound form. It is unnecessary to discuss then further, sincethey seldom occur except in rooms of especial importance. (Div. F). For ordinary rooms or simple elements of the building, the horizontal form of ceiling is most natural. It will therefore be taken as a basis, and the rectangular form of room be fixed upon as the leading one, both in section and in plan. The dimensions of the room, its length, depth, and height, are first determined in accordance with the purpose and importance of the building, afterwards according to its construction and the location of windows, doors, etc., opening out of the room.

97. Length: Distance between axes of Windows.

The length of the room is fixed in accordance with the number of windows to be placed in the external wall and according to distances between their vertical axes. The latter varies with the scale assigned to the building. The more important the structure, the greater is the distance between these axes. Buildings for utility or simple dwellings, especially buildings with small rooms and numerous division walls, naturally have small distances between these axes, while monumental structures frequently have very great distances between them. From 6.26 to 8.20 ft. may be given as least distance between axes of windows, 8.20 to 11.48 ft. an average, and 22.96 to 26.24 ft. being the greatest. The distance between axes indeed very seldom falls outside these limits, it not being advisable to assume a greater scale for the building and a greater distance between axes of the windows than the purpose of the building would justify. The lighting of the room would sometimes be injured thereby. But it would certainly be very bad to make distances between windows too small, for the necessary repose in the internal and external appearance of the building would be lacking; the subdivisions would be too small, the relief too weak, and the general effect not imposing. The given average distance of 8.20 to 11. 47 ft. will therefore be exceeded in important private residences, and especially in many public buildings, on account of their purpose. (See Table).

But if definite reasons permit the arrangement of windows and other openings close together, it is then advisable to combine them in pairs or groups, thereby obtaining large axial distances and more imposing effect. Whether the room has one, two, or more windows in front, depends on whether its average length is one, two or more times the axial distance between windows, less the thickness of division wall. The pier between the windows is the place for the location of the division wall, which need not be exactly at the centre of the pier. Less than the half is often sufficient at one side of the window and more is often necessary. (Figs. 118 to 120.).

98. Depth: Position of Doors.

The depth is the most important dimension of the room; other dimensions are to be arranged in accordance therewith, and in designing the building, we therefore commence with the depth of the room, selecting the form of ceiling to suit this. The depth itself depends on the possibility of good lighting by day. If the ceiling be suspended from the framework of the roof, or rests on girders, isolated columns, division walls, etc., spaced at such distances as to require no support between them, then may depth be taken at pleasure, provided that sufficient natural lighting is also obtained. In rooms of unusual depth (Div.5, Chap.4), one of the indicated methods of construction must be employed to secure the required depth; but for rooms of unusual size, the simplest construction is to arrange the ceiling so as to be free between the walls. It generally rests on the external and middle walls, and the depth of the room is then naturally limited. Even with iron beams, the depth can scarcely be made more than 24.6 to 26.2 ft. without using girders, or seldom over 21.3 to 23.0 ft. with wooden beams, generally having an average depth of 16.4 to 19.7 ft. This is sufficient for ost purposes; less depth frequently suffices, and only in buildings with large rooms will more be required. The latter require sufficient clear height of the room, if the lighting only occurs along its longer side.

But the depth is primarily fixed by the use of the room, which demands available wall surfaces of a certain length. Therefore, if economy requires the least possible depth of room, we may decide on the possibility of so placing the connecting doors of the rooms in the division walls, that the required wall surface exists at both sides. For most purposes it is sufficient, beside the door from 6.56 to 6.89 feet remain to recieve larger furniture, with from 3.28 to 3.61 ft. at the other for smaller pieces. According to whether a single or double door is employed, for which with architrave from 4.26 to 5.90 ft. is to be allowed, there results a depth

or 14.75 ft. as in Fig. 118, or 18.40 ft. as in Fig. 119. Whether the door is set near front or rear wall depends on which portion of the division wall is to be best lighted in the day time. Custom influences this, but if the door is set in the middle of the wall, as in Fig. 120, a depth of 18.00 to 19.70 ft. is required. The arrangement of heating apparatus is important for the wall surfaces. The preceding figures are based on given average dimensions. Yet they permit reduction if necessary. The depth is but rately fixed for a single room, since a series of rooms generally have the same average depth.

99. Height: Arrangement of Windows.

This is true for the ehight of the room, since the stories extend through horizontally, a break in this arrangement being only occasionally found. Height of stories has remained constant for centuries in buildings of the same kind, and may within certain limits be considered as fixed. Like dimensions of rooms, the doors, windows, etc., are in detail fixed by the height of man, otherwise by the mode of use. Heights of stories of ordinary buildings are seldom less than 8.20 to 9.84 ft. or more than 11.48 to 13.10 ft. But for buildings of munumental character, the lower or upper limits may scarcely be given; yet heights of 19.70 to 26.20 ft. are not at all unusual in places (See Table)

But buildings for purposes of mere utility frequently require heights exceeding the usual ones. For their dimensions, one must chiefly judge by size of room, especially by its depth, and it must be made higher, the deeper it is, so that parts most distant from windows may be well lighted; this will be more effective, the higher the top of window, whether window sill be somewhat higher or lower; for the latter is only decided by the use of the space next to the window. Therefore in deep rooms to be well lighted, the window should extend as close to the ceiling as possible (Fig. 121). This causes difficulty if the beams are perpendicular to the front wall. Such high locations for windows also appear inadvisable for most buildings; some wall space is required above lintel or top of window opening to recieve curtains, blinds, etc., for reducing the light. This produces the usual arrangement in Fig. 122.

It is permissible in case of necessity to break the levels of the stories on account of certain rooms, which must have greater height. This may be done in eitther of three ways:

1. By dropping the floor, the room then usually being in the ground story or above subordinate rooms (Fig. 123).

2. By raising the ceiling, above which the roof is directly placed, so that the height of the roof can be entirely or partly utilized. (Fig.

(Fig. 124).

3. By extending the room through two stories, whose total height is required.(Fig. 125).

It must always be remembered, that these arrangements must not make the construction much more difficult, mor may passage within the building be impeded.

100. Proportions.

In determining the height of such unusual rooms, a factor of importance in esthetic relations is to be considered, which may be neglected for rooms ,f ordinary dimensions arranged in continuous stories. This comprises proportion of its interior, or the ratio of its dimensions. For determining these, the point of view of the observer in the room itself is decisive, even more than for the exterior. The following data may serve as approximate rules, where length and depth are to be taken between the points of support of the ceiling, and height is measured between floor and ceiling.

According to old and well known rules:-

1. Height = 2/3 to 3/4 the depth.
2. Height = 1/3 (length + depth)
3. Height = 1/2 (diagonal of rectangle of length and depth).

According to Durand:-

4. For horizontal ceilings:-
   Height = depth, if length exceeds depth.
   Height less than depth for square, polygonal or circular rooms.
5. For vaulted ceilings:-
   Height = /1/2 times depth, if length exceeds depth.
   Height = depth for square, polygonal or circular rooms.

But these rules will be so modified for rooms ofl unusual size that the height may be so much less than the depth, the greater the absolute dimensions.

According to Fergusson:-

6. Height = 1/2 depth + square root of length.

The first rule makes the height depend upon the depth and is very arbitrary; rules 2, 3, 4, and 5 are frequently inapplicable. In the last two, Durand has correctly recognized that the height of the room is not alone to be brought into relation with its length and depth, but also into harmony with the form of the floor and ceiling. Yet he proceeds arbitrarily, when he makes the height of the room equal to its depth, or to one and halfl times the depth. Fergusson's rule gives rather inadequate height for small rooms with length and breadth less than 16.4 ft., but very suit-

able height for large rooms. If several large rooms occur in a story, a suitable average height is to be assumed. When these are of sufficient importance, subordinate smaller rooms may be arranged in two stories by inserting an intermediate floor.

Dimensions of rooms are also determined in accordance with space required for their purpose, generally being calculated for the number of persons assumed therein. These details are referred to the discussion of the different kinds of buildings, and for the usual dimensions of doors, windows, etc., see Part III of this Handbuch. A collection is added of axial distances, depths and heights of rooms, taken from a number of the most important buildings, mostly recent. The absolute dimensions are in many cases fixed by the uses of the room, but in other cases are influenced by the rank and importance ofthe building. As an example of the earlier period for comparison only, is added the Loggia dei Lanzi at Florence, built about the middle og 14th century, which is perhaps unsurpassed in beauty and grandeur of proportions.

TABLE OF BUILDINGS.

A. = distance between vertical axes of windows in feet.
D. = Depth of room in feet.
H. = clear height of story in feet.

Kind of Building.	A.	D.	H. 1st.	H. 2nd.	Notes.
School, Munich	5.25	26.1	12.5	13.5	5 lg. windows per room. dble. seats.
Farm buildings, Frankfurt	5.90	12.5	8.2	----	A. = width of stall
Res. of H. Fischer, Vienna,	6.56	19.7	12.5	13.8	3 W-ws combined.
Res. of H. Wahner, Aix-la-Ch.	7.55	20.1	14.6	11.7	
Prison, Plotz. Berlin	8.20	13.1	10.8	10.8	A. = width of cell
Central Hotel, Berlin	9.35	19.7	17.4	14.0	Front, Fiedrich St.
Assem. Bldg., Neustadt	9.86	29.5	19.7		A. = unit of bldg.
Post Office, Stettin.	9.86	19.7	15.4	15.4	Simple & richer win-
Verein Bank, Stuttgardt.	9.86	20.4	14.1	15.4	dows alternate at 2 A
Building School, "	11.0	23.3	14.4	14.4	A. to 2 Drg. Tables.
Frank. Hotel, Frankft.	11.20	24.2	19.7	13.2	Central portion.
Main Bldg., Univ. Strasburg.	11.20	46.6	19.4	31.8	Ent. hall & main hall.
Court House, Stuttgardt,	11.30	21.5	16.4	15.2	Main front.
Theatre, Riga.	11.50	29.9	13.8	18.4	Ent. hall & foyer.
Polytech., Berlin, M. Bldg.	11.80	27.9	19.6	20.5	A. = 10 small or 8 large seats.
Stad. Art. Inst., Frankfort	12.30	14.8	19.7	16.4	A. = width of rooms.

Kind of Building.	A.	D.	H. 1st.	H. 2nd.	Notes.
Chem. Inst., Univ. Vienna	12.50	23.0	17.8	19.7	A.=2 working plcs.
Rathans, Vienna	12.50	25.0	14.5	23.6	A.=unit of bldg.
Govt. Bldg., Dantzic	13.15	21.0	16.1	31.2	Central Building.
Abatt. & Market Budapesth	13.40	25.0	11.2	----	A.=4stalls.
Library, Univ. Of Halle	13.80	26.0	14.1	14.1	A.=2book stacks, 2 tiers to story.
Gen. Hospital, Berlin	14.00	29.9	17.4	21.4	A.=2 beds.
Anhalt R.R. Sta., Berlin	14.40	44.3	----	29.5	Waiting room.
Harmonic Society, Heilbrau	14.80	18.1	14.8	18.4	
Vict. Storehouse, Berlin	15.30	60.8	9.2	8.9	
Royal Villa, Berg.	15.80	25.0	19.7		N. front.
Castle Hummelshain, Jena.	16.4	32.8	16.4		Main front
Meininger Bauk., Berlin	16.6	18.4	15.6	16.1	Double windows.
Barracks, Lubec.	16.8	30.5	11.0	11.0	A.=room for 10 men.
Abattoir, Berlin	17.1	30.8	20.7	----	A.=1 place.
Theatre, Berlin.	17.2	45.4	15.4	44.3	Concert hall 2 story.
Bourse, Vienna	17.8	36.7	29.5	46.0	Ent. hall & hall on main front.
State Library, Stuttgardt.	17.8	59.0	16.4	32.5	A.= 2bookcases; 4 tiers in up. story.
Spinn Block, Berlin	18.4	18.7	15.1	14.4	For 1st & 2nd stories.
Wohler School, Frankfort	19.7	36.1	17.1	32.8	Grouped windows aby. Ent, hall & main hall.
K.W. Gymnasium, Berlin	20.0	30.5	14.4	14.4	A. = 1 schoolroom with double window.
Borsig Palace, Berlin.	20.4	20.7	23.3		Voss St. front.
Res. Thonet, Vienna.	21.4	39.4	16.4	14.4	1st & basement stories together: A.= 2 windows in 2nd story.
Polytechnikum, Zurich.	23.6	36.1'	26.6	29.5	Central portion:- A. = 2 windows in basement.
Pal. Reichstag, Berlin	26.8	42.7	21.4	38.5	Main facade, centre.
Art. Ind. Museum, Berlin	27.8	26.3	20.7	24.0	Grouped windows.
Main 4.4. St. Frankfort	29.9	180.0	78.8		Central building.
Museum, Arsenal, Vienna	35.5	39.4	24.3	38.5	A. = 1 stand of arms.
Loggia d'Lanzi, Florence	38.5	35.8	76.7		Total height.

b. Lighting of Rooms.

101. Natural Lighting.

Natural Lighting by sun light will be treated here, and is introduced through openings in the walls, ceiling, or roof. These either open di-

rectly into the open air or into a well lighted room above or at one side. Direct light is obtained in the first case, borrowed in the others. Still dspecially in side light, a distinction must be made between that from the entirely unlimited exterior and that from a limited space , streets or courts, enclosed by adjacent buildings, light then being partly reflected. These openings are also means of ventilation, which then occurs in the most rapid and natural manner; j in our climate they seldom remain open, but are mostly closed by sash windows, or by glazed skylights in ceilings or roofs. Glazed doors also sometimes light a room. It is only necessary to mention these arrangements, so far as their location in wall or ceiling and the required area of light surface for the room are concerned. Quality of light depends upon the mode ,f lighting:-

1. Whether low or high side light or ceiling light is provided.
2. 2hether this is direct or borrowed, side or ceiling light.

The climate, season of year, location and surroundings, also influence intensity of light.

102. Glass Area.

In determining the glass area, these factors are to be considered; the use of the room is of great importance, and it is to be remembered that intensity of light diminishes inversely as the square of the distance increases. Since light is broken and diminished by glass, the window is to be considered as a source of light, and the distance is to be taken from it. All these are to be taken into account in given cases, and the light area determined accordingly. Requirements based on the use of the room will be mentioned in successive volumes of this Handbuch under different kinds of buildings, such as school houses, exhibition buildings, museums, etc. Reliable methdds for determining quantity of light introduced through windows into any given room, will be given in other volumes of this Handbuch. These processes chiefly consist by means of solid angle measurer, in measuring the pyramid of light directly radiated to any point in the room to be examined.

The general rules are unsafe and inaccurate, such as that for lighting rooms of ordinary height, 1/7 to 1/5 of the floor area is to be taken as the glass area, and that the top of the window must be at a height above floor equal 2/3 the depth of room, etc. For openings may thereby be fixed, which may sometimes introduce insufficient light, or may supply more light than is necessary. The latter results much more frequently than the former, using the ratio of 1/7 to 1/5, and a window opening fixed by this rule often produces such abundant lighting of the room, that this light must be at times obscured by curtains, shutters, etc. This is true for

both side lights and skylights; if the former are more frequently limited by surroundings than the latter, then is the light from the latter so much the less intense, being usually recieved through the roof, at a greater distance from the floor, generally through two thicknesses of glass. Reflected light is especially unsuitable and disturbing and should therefore be avoided.

103. Direct and Indirect Lighting.

Only rooms recieving direct light can usually be said to be well lighted. Windows are used for this purpose, and their lintels or tops are placed as high as possible, according to Art. 99. The rectangular window is most suitable, admitting more light than any other form of equal width and height. Height of sill window is fixed according to use of the room. The usual height of 2.48 to 2.82 ft. is especially applicable to living rooms, and is such that one can conveniently open the window and look out. In many cases (schools, prisons, etc.) both of these are not intended, but merely to light the room, and such a low sill would not be advisable. The sill is then higher, in many cases above the head as in halls, to afford protection from draughts through crevices of windows. (Fig. 130). Borrowed light should be employed only in subordinate rooms and when unavoidable, but only with care and so as to make ventilation by the openings possible. Therefore windows should be arranged in addition to skylights, or at least air flues should be provided.

104. High Side Light and Ceiling Light.

High side light expecially occurs in rooms of great depth, and in those of such great height that windows are placed above roofs of adjoining rooms (Fig. 126). Notable examples of these are domed structures and basilican designs (Figs. 127,129). Rooms of very great depth require for good lighting windows along both long sides as well as along the ends. Yet one should avoid placing windows where unnecessary. Ceiling light is frequently arranged, though improperly, with entire exclusion of side light. Both often influence the form of the ceiling (Figs. 128,130). Direct ceiling light can only be obtained in a room located in the upper story; yet it may also sometimes be utilized in lower rooms, as in Fig. 128.
The value of ceiling light in comparison with that of high side light is explained by Boileau in Figs. 131, 132. These illustrations exhibit both modes of lighting arranged in the same room, for example, in a hall 32.8 ft. wide with side rooms 18ft, wide extending along the long sides, with two stories of galleries above. These side rooms recieve light only from the opening in the ceiling, or from side openings in upper wall of hall. For points O, L, I, F, of the floor, the number of light rays falling on

each are found for a cross section plane through the central angle in both cases. These give the following results.

	Fig. 131.	Fig. 132.
For point F	47 degrees.	13 1/2 (9 + 4 1/2) degrees.
" I	42 "	11 1/8 (11 + 1/2) "
" L	28 "	10 1/2 degrees.
" O	9 1/2"	9 1/2 "
" B	0 "	0 "

If these values are laid off as ordinates on the axis of abscissas, B, O, L, I, F, the areas of the hatched surfaces given in the two illustrations represent the relative quantity of light, which for an assumed distance of 8.58 ft. between the points, are in the proportion of 202 in Fig. 131 to 78.5 in Fig. 132. The number of light rays be similarly determined for points in the two galleries. The length of light openings is neglected in both cases. For complete comparison, this must be taken into account, i.e. there must not alone be measured a section plane through the opening for light, but the volume of the entire pyramid of rays, whose base is the light opening, and whose vertex is the given point, as well as the inclination of the resultant of the light rays. This may be done with the solid-angle-measurer already mentioned.

The light reflected from all sides will be introduced into those parts of the room that recieve no direct light (vertically hatched in Figs. 131, 132). It is to be ascribed to this, that high side light and omission of ceiling light as in Fig. 132 affords a light less bright, but much milder and more uniform than ceiling light, which has a very dazzling and disturbing effect. Fig. 138 is an example taken from a Vienna building with the arrangement in Fig. 131. A kind of high side light and very effective is afforded by saw-tooth or shed roofs. The glass area should then be turned to the north.

The lighting of rooms located in the intersection of two parts of the building is generally difficult. It is either by a ceiling light as in Fig. 133, or large side light windows are arranged at one end of the room as in Figs. 134, 135. Or the room may be lighted like the so-called " Berlin" room. Direct sun light is then usually introduced obliquely as in Fig. 142). For indirect lighting inside rooms, light courts or light shafts are frequently arranged, enclosed in the building and recieving direct light from above. These generally have a single or double glass roof (Fig. 138). By their enclosed location and high roofs ventilation is obstructed, light is not uniformly diffused, and the side walls are brightly lighted; but the glass or area should not be too small, not less

than 21.5 to 53.7 sq. ft. for light shaft, or 107.5 sq.ft. for light court. The ordinary "area" in English houses in blocks has many advantages, and is also an effective protection against penetration of dampness horizontally. This kind of light court, like that in Fig. 137 is frequently employed. Low lying cellars must often be lighted by small light shafts constructed in the masonry opening in the surface next the court or street being properly covered and protected (Figs. 138, 139).

105. Artificial Lighting.

The artificial lighting of rooms and location of lighting fixtures do not exert as much influence on the plan of a room as the natural mode. The removal of gases of combustion from lighting fixtures arises, and if these are also to serve for ventilation, this factor may within limits determine the treatment of the room. How this may influence the form of the ceiling and of halls will be shown in the last chapter of this volume.

c. Arrangement of Chimneys and Heating Apparatus.

106. Chimney Flues.

The choice of heating system and arrangement of heating apparatus are of great importance, both for room and for the building to which it belongs. We only mention apparatus for local heating, such as stoves, fire-places, etc. connected with these are the flues, in regard to which it is to be noted, that they should be placed in the rear portion of the room and in the interior of the building, preferably in middle walls supporting beams in Germany and Austria, in division walls in France and England. In the last case, every other division wall is made thick enough to recieve the flues, but frequently only the middle wall in the first case. According to arrangement of walls and beams and to the weakening of masonry by openings, numerous exceptions from the rules occur in both cases. Both methods are required partly by different construction, partly by nature of the heating apparatus. The flue is objectionable when it projects from thin walls. External walls are least suited to recieve flues, partly from their less protected situation, partly for the great height to which they must rise free above the roof to a point higher than the ridge. In simple buiodings with flat roofs, this objectionable feature will be very visible, while on rich facades with steep roofs and gables, the chimney caps may be effectively employed as motives for artistic treatment of the external architecture.

107. Heating Apparatus.

Otherwise flues are to be arranged according to location of stove or fire-place, this being fixed according to the uses of the room. This raises the question of kind of heating apparatus, and whether it is to be sel-

exted with sole reference to heating the room, or with regard to pleasing appearance. In the first case, the stove is so placed as to interfere least with use of the room, but in the second, it takes a prominent position as an ornamental object of internal decoration.

The fireplace with open fire is a luxury, common in France and England but in Germany it occurs only in sumptous buildings, then being usually combined with a central heating system. It is a very effective element in the decoration of walls, and is therefore arranged on the axis of a room, where it occupies slight depth but considerable width in rich designs. Its chief charm is the open fire and hearth, around which persons gather for cosy, quiet and intimate conversation, so that in social and family rooms it is best placed at the centre of a long wall (Fig. 140) or against a broad pier. In French plans it is often placed in a window recess. For rooms of societies and larger halls, a location between two doors is effective, as in Fig. 141, the opening above chimney breast being closed by a mirror or plate glass affording an effective view into the adjacent room.

The tile stove has been so perfected in form and color recently, that as an object for effect it is scarcely inferior to the fireplace, even sometimes surpassing that. Even if arranged with an open fire, it is seldom placed at the middle of a long wall, as it projects much into the room, space around the stove is not comfortable and furniture cannot be placed near the stove. In accordance with the location of the flue, the best place for it is in one of the rear angles next the middle wall, as in Figs. 142, 143, or beside a door, where sufficient width exists. The use of the room decides the location of the usual terra cotta and iron stoves; it also locates the wall-stoves, which extend through the wall, as in Fig. 144, and heat two adjacent rooms. Stoves heated from the exterior were formerly common, but are no longer used and their great projection is thus avoided.

To avoid discomforts resulting from isolated heating, the fully developed central heating systems afford means. Without discussing location of radiators in separate and central heating, or the arrangement of openings for admission and removal of air, it may be briefly said that these are to be suited to the decoration of wall surfaces, and that due regard must be paid to the selected system of warming in the design.

Chapter 3. Forms of Buildings.

108. General.

Without reference to its purpose, the erection of a building is in a general way the creation of an enclosed space. A building usually consists

of several rooms, serving for different purposes (Div. I, Chap. 1-9-12), arranged suitably beside and above each other. The last produces buildings of one or more stories, and according to their location, the cellars, basement, lower, ground, upper, and attic stories are distinguished, as well as intermediate or mezzanine stories.

109. Buildings without Internal Rooms.

The enclosure of space is not always the purpose of the building. For many buildings possess no internal rooms at all, or are without internal effect. Here partly belong those highly important works in ornamental architecture, which only serve an ideal purpose, embody a spontaneous idea of mankind, and are therefore erected as monuments in honor of the Diety, or in memory of notable events and persons. Isolated portals and gates belong here, as well as certain objects transferred to architecture, like fountains, wells, candelbra, vases, etc., which by nature and origin belong to other technical arts, and those pertaining to landscape gardening. But since external form is both beginning and end of this problem, and the design and arrangement of the building according to the views of esthetics, this is not the place to further consider them.

The following articles will treat only of the building in the usual meaning of the word, and as being produced by combination of separate space-forming parts. Progressing from simple to compound, and commencing with the ground plan of the building as a proper basis of the design, the exterior will only be regarded in its chief outlines.

a. Buildings of Simple Form.

110. Buildings containing a single room.

The building of the simplest type contains a single room, undivided in plan and elevation. Arts. 94 to 98 on forms of rooms in general apply here; but one is not restricted in choice of form of plan and ceiling, dimensions, etc., by consideration of adjoining rooms and parts of the building, and so far as the problem permits, may retain the artistic point of view. Simple and regular type forms are especially suitable here. These unpretentious structures frequently recieve richer treatment. The type form recieves extensions as in Figs. 110 to 115, and there appear modified as ante rooms. The problem often affors appurtinity for use of rows of piers or columns, or of other space-dividing structural parts; a transformation upwards of the type form may often be observed, both in the interior and in the exterior of the building. It is generally furnished with a base or substructure, whose height is compensated by arranging steps.

In the external appearance of the building appears a free development of the architectural design, and if simple, especially in the form of roof;

for this directly indicates the type form. The form of ceiling is also of decided importance to the internal treatment, both in construction and form, and according to Art. 98, this may either freely span the room or require other supports between the walls. According to both methods, the structural system of the roof preferably approximates the form of treatment of ceiling of the room; but the latter is often entirely independent of the former. Both are influenced by arrangement and distances between points of support. These buildings, partly of very limited, and partly of very imposing dimensions, have in all ages been most extensively used in architecture as temples, chapels and mausoleums, lookouts or belvideres, pavilions and kiosks, etc., with simpler or richer treatment, and being intended for most diverse purposes, they afford suitable subjects for the artistic creative power (Figs. 145 to 147) Here likewise belong those very spacious buildings, where the nucleus of the design forms a single room, individed if possible, or a hall, then shaped in accordance with Div. 5, Chap. 4 of this volume. The noblest monuments for the worship of the Diety, the cathedral and the church, are also included, as well as enclosed structures of all kinds.

111. Tower-like Structures.

The building is further changed, if the problem requires a division of space in height, thus forming a design in two or more stories. A necessity then appears for connecting the stories, and stairs serve this purpose, there being sometimes arranged on the exterior, but are usually in the interior of the building. In the last arrangement, a side room is usually added to the principal apartment for a stairway (Fig. 148). Yet the staircase is often built free within the room. This is in towers almost invariably the case; their purpose is less to provide several rooms above each other, than a room of unusual height, necessarily limited or enclosed. The isolated tower is to be first considered, and which as a belfry, watch-tower, fortress-tower and gate-tower (Fig. 149), a lookout, water-tower, bridge-tower, lighthouse, a clock and bell tower or a campanile, is capable of unusually varied treatment. It is indeed the crown of the building, the expression of an elevated room, treated in accordance with the special purpose to be served, and generally affording a suitable and effective motive.

Yet the tower is frequently not detached or isolated, but a very characteristic portion of the design of the building. For churches, city halls, etc., it has acquired by tradition a typical importance. It usually serves as a staircase tower to connect different stories. But such a prominent and monumental architectural mass shall never be so degraded in its

importance, that without any purpose, it is added as a mere accessory, and in paltry dimensions serves as the sport of an erring fancy. The preceding considers only the most important of the buildings of this class, but an impulse is given to deeper study of these very interesting and graceful creations of architecture.

b. Buildings of Compound Form.

112. Principal Points.

As in the case of simple forms of buildings, there again come under consideration two different things, which are of decisive importance in the general form of the structure and which can alone be considered here: the form of the plan and the shape of the roof.

From the latter results the upper terminationk and from the former in a manner, the lower ending. If both are combined and are united by the vertical outer walls with due attention to the changes in form upwards, we not only produce thereby the external form of the building, but also an expression of its interior, sufficient for our purposes. This suffices for the internal form so much the more, since each room appears for itself, and the room was described as the element of the building in the preceding chapter.

1. Form of Plan.

113. Arrangement of Rooms beside each other.

We will first take up number and sizes of the rooms. The question now arises, how and in what order are the rooms to be arranged, and it must first be decided, whether the building is to be in one or in several stories. With all rooms in one story, the horizontal extent of the building is naturally much greater, and even with limited dimensions, the ground form will quite differ from that arranged in several stories. The choice of either mode chiefly depends on number and purpose of rooms, and also on whether the uses of the building require all rooms to be of equal height or not. In the latter, arrangement of the staircases to connect different stories becomes very important; they do not exist in the first, or are of subordinate importance.

114. Rooms for Facilitating Access.

But in both cases, accessibility of all parts of the building is the first requirement in treatment of the plan, and this demands rooms for general use, which like stairways facilitate passage within the building. These are ante and connecting rooms, vestibules and entrance halls, halls and passages, courts, corridors, or galleries, stairways and lobbies, which for their importance are termed arteries of communication in the architectural organsim. They are here only considered in regard to utility and

suitability, and both the beauty and design of the building depend on their arrangement, connection, and their distribution in the ground plan. They must be so designed that separate parts of the building and the rooms may be readily accessible, easily separable, and at the same time may be opened for free admission of light and air. This will be best attained by a clear general plan, with a spacious, but compact arrangement of these means of communication.

While in simple deisgns for houses a vestibule or passage suffices, in extensive and complex forms of buildings, these ante rooms frequently occupy considerable extent. Their plans must be briefly mentioned, since they form a leading motive in the treatment of complex forms of buildings. (Div. 5, Chap. 1).

When permitted by the site and the money at command, corridors are best arranged along an external wall, since communication is thereby favored and light and air are best admitted. Yet this is bad, when the corridor extends along a common division of fire wall, and the same occurs in case of a middle corridor. Both arrangements are objectionable in many buildings. When permissible, care must be taken in their lighting, partly by direct and partly by indirect light. Windows at ends serve for this purpose (Fig. 152), also light corridors as in Fig. 150, or projections of corridors and stairways at proper places are better, and also light courts, skylights and glazed doors as mentioned in Art. 104. Width of corridors varies with their purpose. It is least for servants' passages, and is fixed by the possibility of convenient passage and of placing at the end a narrow door with its finish. In extreme cases 2.95 to 3.28 ft. will suffice; if two persons are to pass each other, then 4.26 to 4.93 ft. will be necessary. But a long or side corridor in public buildings should have a width of at least 6.56, or better 8.20 to 9.84 ft. A central corridor for frequent use is to be made correspondingly wider.

Like all rooms for communication, the arrangement of corridors otherwise depends partly on the building site and surroundings, partly on the purpose of the building, and from their arrangement chiefly results its ground form. For in their combination these rooms form the skeleton of the building, around which are grouped in organic sequence member by member, and room by room. The ground form of the building will also be influenced by other circumstances of a partly practical and partly theoretical nature, by number and size of parts of the building, by possibility of good lighting and abundant ventilation, by regard to external appearance, to suitability, to tradition, etc. Many kinds of buildings, as churches, theatres, hospitals, prisons, etc., have acquired typical ground

forms under the influence of these different causes.

115. Depth of Parts of Building.

The depth of parts of the building determine its form. It was shown in Art. 98 that one must be guided by dimensions of the different rooms, especially in fixing their height and depth in accordance with construction of the ceiling and possibility of good lighting by daylight, etc. Proceeding from these considerations, we find the average depth of a part of the building, as in Figs. 151 to 153; and from dimensions previously given and with due reference to the thickness of the walls, these are made as follows:-

1. For a plan composed of a single row of rooms with or without a longitudinal corridor, about 23 to 39.5 ft.

2. For a plan composed of two rows of rooms with a common central corridor, about 39.5 to 59.2 ft.

3. For a plan consisting of three rows of rooms with two corrdiors, about 59.2 to 82 ft. or more.

116. Extent in Length and Height.

The depth of a part of the building is determined thus, and unless unusually large rooms are provided, it will be kept within these limits. After either three arrangements is chosen, assuming the ordinary rectangular form, the length of the building is easily found, after the ground area to be covered has been approximately determined as explained in the next Chapter. Its height is afterwards most simply computed from number and height of the different stories.

11u. Ground Form.

If the length obtained in this way differs little from depth of building, an approximately square or slightly rectangular form is given to it, and is usually one preferable (Fig. 154) It has been stated in Art. 94, that the former is more economical, because it requires least total length of enclosing walls, assuming these to be of uniform thickness. But the latter seldom occurs; it is for this reason otherwise in buildings divided by cross and middle walls, since the division walls of a square plan require greater length than for a rectangular one of equal area, though the converse is true of middle walls.

It is not possible without further discussion to state the preferable ratio of length to breadth of the rectangular form, this determination being based on the internal subdivision and must therefore be left to special cases. Yet in arranging in sequence a number of rooms of given areas in a selected form, it is advisable to give to it greater depth and thus a lesser extent of facade. Though greater total length of thin di-

vision walls is thereby required, yet less extent of thicker and more costly outer and middle walls that support the ceilings and roof is necessary. To reduce the total length of the latter to a minimum is certainly most rational, though attainable only within certain limits. To fix these limits is important on account of cost, both for simple and frequently repeated designs, where maximum economy is required, and for large and important structures, since with their extent economy in cost increases. The general arrangement of plan must be fixed before relative dimensions of the ground form of building may be so computed, that with unchanged area, the total volume of walls may be made as small as possible. Attempts have been made to do this. Fuhrmann investigated detached buildings of rectangular form and those composed of rectangles. Maurer made similar inquiries, and went further by finding the cost of constructing the walls, and also that of excavations, and of constructing ceilings and roofs. Schmitt, for special buildings (houses for railway guards) assumed fixed areas for the different rooms, and computed dimensions of length and depth to be assigned to each room.

With a large ground area to be covered, and after depth of building has been determined, an elongated rectangle results as its general form. As usual for long external walls, projections are preferably arranged at the angles or center, as in Fig. 155, in order to thereby obtain better proportions of the masses in the treatment of the facade. Care must be taken to make these projecting masses either decidedly wider or narrower than the recessed wall surfaces. Approximately equal subdivisions produces monotony, and too frequent projections and recessions of relatively small dimensions have a disquieting effect. These projections also serve to accent important portions of the building, and should in all cases correspond with divisions into rooms in the interior.

Yet for a very extended length, it often becomes impossible to take the simple rectangle as ground form of the building. It is permissible to add wings to the main building. Combinations of rectangles are to be preferred, which suit the site and fit the programme, According to circumstances, combinations in Figs. 156 to 160 are suitable therefor, are partly symmetrical, partly unsymmetrical in arrangement. These are all open forms, or permit free access of light and air on all sides. With these may be contrasted closed ground forms having one or more internal courts, as in Figs. 161 to 164. Variations in Figs. 162, exhibit specimens of partly circular, partly oblique form.

Ground forms of greater extent and of varied shape result, when from detached dependent buildings for a common purpose, a united group of struct-

ures is to be formed. Figs. 185, 186, are examples, where buildings really belonging together in plan are in part closely, and in part loosely connected. In many designs of similar character, combination is intentionally avoided. The decision of which ground form is preferable must be left to the different cases; also whether symmetrical or unsymmetrical grouping is to be preferred. Referring to Div. I, Art. 21, it may be briefly stated, that not only in buildings of monumental importance, but also in those built in solid blocks, a symmetrical design is usually more suitable, and for isolated structures on elevated sites among picturesque natural surroundings, a freely and boldly subdivided type of plan is best adapted. The ground form must always correspond to the purpose and be truthful, therefore be developed from interior outwards; it must not be fixed with sole reference to external appearance and be an artificial exterior, but must be suited to the mass of the building. Hence one must not build from exterior inwards, but from interior outward, to determine the form. This treatment of the interior and the division of the plan in detail will be taken up in the next chapter, referring to selected examples. Aside from these, we must then examine different modes of treating the plan, originated by requirements and views of the time, which appéar in the suprising and artificial forms of castles and palaces in the Barocco and Rococo periods.

2. Treatment of Roof.

118. Ceiling.

The form of roof and the form of ceiling influence arrangement of plan in some buildings, especially in structures containing large rooms, and which belong with the halls and assembly buildings described in last division; otherwise, the plan influences the roof in form and construction. In regard to forms of ceilings of entire buildings, it may suffice to remark that according to Art. 99 ceilings are generally arranged in accordance with the division of the building into stories, and variations from this rule only occur in cases of especial importance.

119. Forms of Roof.

Treatment of the roof as upper termination of the structure is capable of unusual variation and improvement. It contributes to the characteristic and effective exterior of the building, not less than combination of the different masses and subdivision of these masses horizontally and vertically. These motives have an essential influence on the form of the roof, which is determined by the following factors:-

1. By the horizontal section or ground form of the building, which results from combination of the different parts of the structure and fol-

lows changes in direction of external walls.

2. By the vertical elevation, which either terminates at a common height or at different heights, according to whether the different masses of the building have the same number of stories or not.

3. By the form of cross section of the roof.

4. By the possibility of proper removal of rain water.

The first three factors occur in such varied ways, that their combined effect produces numberless forms. The fourth is no less important and causes important difficulties in buildings with closed forms of plan having two or three rows of rooms (Art. 115), as well as for houses in blocks and those of irregular plan. It is sometimes necessary to arrange the interior portion of the building as a kind of platform of slight slope, rain water pipes being carried down within the building itself, an arrangement only to be employed in the most extreme cases and with the greatest precautions. It is not necessary to investigate how the removal of water is best attained; yet this si shown in part by the following illustrations.

Some combinations of roofs are partly produced by variation of ground form and partly by difference in height, the upper termination of the building being effected by the surfaces of the roofs, as represented in Figs. 167 to 173. These are based on the most useful combinations of different parts of the building as described in Art. 117. These examples suffice to show the influence of form of roof on main form of the building, and to illustrate their external appearance, together with the grouping of the masses of the building resulting from form of plan. The illustrations are here based on the usual forms of sections already employed for simple forms of roof. They principally differ in greater or lesser inclination of plane roof surfaces, instead of which curvdd surfaces are common. From combination of these simple forms result compound profiles as in Fig. 174.

120. Development of Roofs.

That forms of roof are very capable of bold and graceful treatment is shown by numerous classical creations of the mediaeval and Renaissance periods, especially by monuments in northern countries, since men were there led by climatic conditions to the most suitable design for these portions of the building, for which these periods well understood how to invent artistic forms suiting the locality is proved by well known historical examples.

The same conditions exist now as in earlier times. The form of roof must afford protection from rain and sunshine, and this requirement must be expressed by its treatment. Why should we be ashamdd of this neces-

sary and rational protection and seek to conceal the covering of the buildings. The stupid imitation of foreign monuments, built under another sky and for different customs, led to this error. This must be the reason that men recently constructed flat roofs alone and neglected their development. For whatever is not readily visible recieves no care. Roofs certainly afford motives for the uppermost adornment of the building, and masterpieces produced under conditions that still exist, may serve as models.

It is then clear each part of the building must have its roof, and every important room must be distinguished by a crowning portion of the roof, gable, etc. This occurred during periods of highly developed architecture, and it was reserved for periods of decadance to place halls and kitchens, large and small rooms, under one roof and to clothe then with a monotonous covering. This is called "monumental repose". Such views have fortunately dissapeared; men are convinced that by rational forms of buildings and by natural grouping of architectural masses better effect is produced than by vapid ornament or worn-out motives for architectural treatment. Employed in a massive way, this is but a means of obtaining suitable importance for the modest rural building, as well as for the prominenet monumental structure. Men have sometimes gone too far, and a danger exists that the picturesque element may obtain the mastery.

Chapter. 4. Designing.

121. General.

The problem for the architect in the erection of a building has been brought within narrow limits, and we have more nearly attained the proposed end, the designing and representation of the structure. Moreover to reach this aim, besides the creative idea, neither system nor order must be lacking; an attempt will then be made to indicate the beginning points from which designing is to proceed, while some examples will be added as illustrations. Each problem must be considered as a whole, and in designing the plans, we must pass from general sketches to details.

This is not opposed to the given law, to build from the interior outward and not from the exterior inward. For this comprises exactly the difference between research and invention, between study and personal creation in architecture. To solve the requirements and arrangements of a building, and to deduce conclusions for the plan of the building, are the process of study and solution of a problem. To commence with designing of structure as a single coherent whole, to pay due regard to its chief points, then to consider requirements in detail, to arrange all in order and bring them into harmony, is the method of independent creation and

of artistic design in architecture. Thus to first hew the statue in the rough without regard to fashion of the clothing, to first fix the structural organism, to bring every member to its place, to concede prominence to the important, to retire the unimportant, to arrange and join everything in due sequence, and lastly, to give to work shape and form, is the problem for the first sketch.

122. Design.

The design intended for execution is not the work of a moment, or result of the first and best idea, appearing in a quickly made and talented sketch; only after hard labor and conquering the difficulties of the problem, does the idea attain perfect clearness. The first sketch is followed by a second and a third, the work becomes simplified, obstacles disappear, the essential becomes prominent and the unimportant recedes, and we suddenly see the path leading to our aim. Earlier sketches no longer satisfy us; a new and better image of the object is before us; we lay hand again to the work, which is tried and changed, this part being transferred from right to left, that from front to rear; every part now assumes its natural place, as if it could not be otherwise, and the problem is solved. To bring it to this point, no pains are spared to test it again and again until the building is developed in clear and simple form, for which both stern self-knowledge and untiring creativeness are necessary.

Yet the plan comes first and then personal criticism. Never permit paralyzing doubt to appear, that disintegrating criticism of the creative thought, before this is developed, for despondency is just as objectionable as overweening self-conceit. One does not first loose himself in details, which readily arrange themselves afterwards. With pencil in hand and fresh for the work, it is then tested, changed, and again tested, which is the way to attain the end. In accordance with the preceding, the design of preliminary ground plan is most important. If the building be built up in the mind, one may have a general image of the entire work; but he cannot proceed at the same time with everything necessary to its graphical representation. We must commence with primary drawings, with the ground plan, and not with the elevation of the building. Attention is given to the ground plan first, and in designing it, the factors of the problem before developed and which influence external and internal forms of the building will be considered in the proper place.

123. Plan of Site.

One should then commence with the location and aspect of the building, according to Art. 88, and these are shown on the plan of the site. This exhibits the form of the ground for the building and its surroundings.

On it is provisionally drawn the ground form of the structure, existing or contemplated streets and alleys, plans of gardens and out-buildings, enclosures and gateways are also shown, and heights and other conditions of the ground are noted and utilized in the best manner. The determination of the general plan is naturally first made; this requires further attention, should the design be materially changed during later studies. But in order to give merely approximate extent and ground form of the building on the location plan, an approximate calculation of area to be covered by the building is required. By the aid of the programme this is usually made as follows.

124. Area of Ground Covered.

After the number and sizes of the useful rooms have been fixed on the basis of space requirements of programme, and the total of superficial areas obtained therefrom, we add to this a certain per cent for thickness of the walls and for vestibules and rooms for passage, which varies for the chief kinds of buildings, and is to be so taken that sufficient margin remains for additions and reductions required in combining them together. From experience, this may be taken at 30 to 40 per cent for buildings of utility, for ordinary dwellings and private houses, and for buildings with very large rooms and proportionally few vestibules and corridors, etc., at 50 to 70 per cent for simple and compactly arranged public buildings with two rows of rooms and common central corridors, and at 80 to 100 per cent for rich and expensive designs of this kind with spacious entrance halls and stairways, corridors having rooms along one side only.

The numbers afford only a general and probable basis and are taken within wide limits. But by comparison of the structure to be designed with executed buildings of similar character, the total floor area of all the stories of the former may be easily computed within closer limits, and after the number of stories has been fixed, the ground area to be covered is found approximately. It is to be considered next whether isolated rooms are placed in a mezzanine story or in an attic extending over the uppermost story.

125. General Arrangement.

After proceeding in this manner, especially in the larger programmes, and after the approximate cost of building has been estimated according to Art. 90, it is then proper to decide on the general arrangement of the building with due regard to its site and surroundings, and it should then be made clear according to Art. 117, whether it is to form merely a single enclosed mass, which must be solid or opened by one or more courts,

or whether separate wings of the building are to be arranged, and these are to be connected or detached, or finally, whether the whole may have an equal height, or whether some parts of the building are to be lower and others are to be made higher.

126. Ground Plan.

Passing from general to details, from great to small, we then have to determine the principal rooms and the rooms subordinate to them, what rooms belong together, and which are to be separated, or briefly, how and where everything is to be most suitablt placed on the plan. Requirements in detail and advantages and disadvantages of the intended arrangement are to be considered together, and since it is never possible to have everything in equal perfection, the important must take precedence of the unimportant; accordingly even in the sketch ground plan, chief rooms are to be distinguished from others, that they may be recognized at the first glance.

The problem will be the more simple, the smaller the number of rooms to be combinedd in one story, and the more freely one can arrange them. Even combining together similar rooms in several stories presents no difficulties, compared with those of rooms varying greatly in size and purpose, to be arranged beside and above each other. Not only depth, but also height of the rooms will then sometimes be dissimilar, and interruptions of the stories become necessary; form and construction of the structure and its lighting will be more difficult, especially in rooms beneath large halls and at intersection of the wings of the building. Upon the skillful utilization of these intersections and of other unfavorably located portions of the plan, the connecting of vestibules, stairways, rooms with skylights, light courts, etc., with adjacent subordinate rooms, which are often added at such places on the plan, depends chiefly the successful solution of the problem.

In designing the plan, the lighting of all parts of the building determines the ground form and internal subdivision, and affects its general arrangement. We commence with the arrangement of rooms and parts of the building, fixing depths of the rooms and heights of stories in accordance with previous statements, then proceeding with arrangement of vestibules and of rooms for communication. This is to be decided next after location of the principal rooms and of entrances to buildings; these being the purpose of the former. Separate entrances for persons and for carriages are frequently required, whose proper connection with corridors, stairways, etc., forms an essential part of the problem. Center lines of halls and of entrances usually indicate axes of direction of the build-

ing. Their coincidence is indispensable in monumental buildings, but is to be preferred in less pretentious structures. The principal axis of the building is perpendicular to its principal facade, the transverse axis extending parallel to it through the middle of the building. Parallel to these two directions side axes often extend through the centers of adjoining or receding buildings on each side.

127. Subdivision by Axes.

Subdivision by axes generally extends to the exterior, as well as the interior of the building, even if in freely combined and irregular ground forms, offsets or breaks in the middle lines occur, caused by the arrangement of the plan. If this be fixed in its chief points, windows and doors, colonnades and piers, are arranged accordingly; and consistently with requirements of order and good construction, the axes of these structural parts are equidistant in the respective parts of the building, unless a definite reason exists for varying from this. Adherence to regular axial subdivision facilitates designing, and is a requirement of architectural composition, when suitability and truth are not violated thereby. This results from ground principles developed in Div. I, and is proved by masterpieces of architecture of all times and countries. Yet the system of axes may not be taken at pleasure. The unit must result from the subdivision of space in the building (Art. 97), and for structural reasons it must harmonize with subdivision by cross walls, lines of piers, compartments of vaults, etc., and not be based upon a mere fancy.

That one may go too far is shown by the designs, which at the beginning of this century were made on the squared system on the theories of Durand and Weinbrenner, which exhibit advantages and disadvantages of their method. Reference is made to works by these authors, and their predecessors, to designs and writings of Palladio and of older masters, which show a rigidly symmetrical subdivision by axes. The arrangement of the principal points of support determines the system of axes. This is evident in larger plans, but also appears in smaller and in freely grouped structures, at least in their chief masses. Such data in reference to absolute unit of measure used as a basis for the system is given in the Table (Art. 100). A comparison of buildings shows that with both very small and very large axial distances it is possible to make the scale of the building clear by suitable grouping and subdivision.

128. The Elevations and Sections.

After the axial subdivision the treatment of external facades and of internal sections is to be arranged, and when the ground plan is substantially designed, sketches are made comprising main lines of facades and

of sections. When the design has progressed so far, a perspective view should be made for a detached building before it is worked out further; valuable indications are thus obtained for proportions and treatment of the architecture, which cannot be properly resented by the elevations alone. For its importance, this will be discussed in the next Division. To illustrate and develop the ground princepal of the designing, plans of some executed buildings will here be given, to indicate the method to be followed in certain cases.

a. Building detached on all Sides.

1. Freely Grouped.

129. Castle Stordalen in Sweden.

However unrestricted may be the plan of a building, the design generally shows an endeavor to arrange the principal parts of the structure symmetrically, to extend the main axis of the building, and to place its different masses according to axial subdivision. This appears in Castle Stordalen in Sweden (Figs. 175 to 177). The illustrations give no information in regard to the surroundings and orientation of the building. Yet the best facade is evidently the principal front, symmetrically arranged about a chief axis A B extending through the entire building. The principal apartments are evidently placed there, and are arranged on a transverse axis perpendicular to A B. In addition to the basement story, the space requirements of the problem are satisfied by a ground story, and a story in the Mansard roof. Other conditions of the programme permit an arrangement of the plan by grouping social rooms and family rooms on the ground and first floors around a common hall from which they are directly accessible and form a complete whole, but so connected that the principal apartments could be used without being disturbed by the housekeeping or by passage of servants.

With the location of the chief rooms on front, the main entrance and carriage porch are connected with the corridor and vestibule, the three latter being placed on the main axis, with the first on a transverse axis C D at the angle of the side and rear facades, all being connected by the principal staircase. The halls are lighted by ceiling lights in both stories. But a servant's staircase with a separate external entrance is required, and is most conveniently placed in the side wing to effectually isolate kitchen and servant's rooms in the basement, which are also directly accessible externally from an area. This produced the plan in Fig. 175. Around the vestibule and corridors are grouped the social, living, and sleeping rooms, of very imposing dimensions, and to which on extraordinary occasions could be added the best rooms of the Mansard story.

It is unnecessary to go further with the subdivision in detail; reference to the illustrations is sufficient, which exhibit an effective elevation of the side facade and the ground plan.

The total utilized area of ground and first stories is 11296 sq. ft., an average of 5648 sq. ft. per story; ground area covered is 7335 sq. ft. hence 30 per cent additional is required for walls and rooms for passage; vestibules are not included in the latter but put with useful rooms, and terraces, hall over the light court, etc., are omitted.

2. Symmetrical Arrangement.

130. Gewandhans at Leipzig.

The nex Gewandhans at Leipzig is a very instructive example of a symmetrically arranged building free on all sides (Figs. 178 to 181). As for requirements of the programme, on a site bounded by four streets the building stands free on all sides, but free development of ground plan was impossible, since its breadth was limited to 131.2 ft. The great concert hall is the starting point, and fulfilment of space, accoustic, and esthetic requirements is the aim of the artistic design. Everything else is only a means for the end but is scarcely less important practically. All influential factors led to the arrangement of two continuous stories, placing the great concert hall in the upper one, together with the adjoin- in gsmaller hall and the foyer. For its importance, the great hall is placed on two chief axes A B and C D and forms the nucleus of the building. The location of the small hall and of the foyer naturally occurred at front and rear ends on two subordinate axes parallel to C D symmetrically grouped in I form. Then from the prescribed total width of 131.2 ft., later increased to about 137.7 ft., as much space as possible was assigned to the width of the great concert hall, bringing these halls into convenient connection with each other and with the ground story.

It was most suitable for the given arrangement to place public stairways at both long sides and leading to different parts of the building. Two other stairways beneath the stage are placed on each side of the organ niche, and permit unobstructed access to the orchestra room and the soloists room, and longitudinal corridors lead to those for the public between the stairways, great hall, and foyer. The smaller hall is placed symmetrical with the foyer and furnished with two additional stairways and a small vestibule, and is located within the area of the old building, to be chiefly used for chamber concerts. But since evening entertainments are generally held therein, it is arranged that the stage and seats can easily be removed. In case of very great festivities, it and the foyer can be opened for general admission of the spectators.

This simple and clear arrangement of plan of principal story produced one equally satisfactory for the lower story. The latter was required to contain certain rooms in proper sequence, suitable to both admit and afford egress to audience and performers. A vestibule with three doors for persons on foot combined with two side vestibules for carriages to form the entrance hall. Next this on the main axis A B is the large hall with clothes room for gentlemen and ladies, then the vestibule to the smaller hall, and on the transverse axis are entrances to main stairways and to the boxes. The external and internal architecture (Figs. 179 and 180) produce a truthful and noble effect.

Without exhaustive detail, the great concert hall, measured between points of support of the ceiling, has approximately these proportions of length: breadth : height :: 4 : 2 : 1.5 (124.5 : 62.3 : 47.9 ft), and including all boxes provides 1588 comfortable seats with space on the removable stage for 104 members of orchestra and 300 singers. The smaller concert hall has nearly the same proportions as the larger, or its length : breadth : height :: 4 : 2 : 1.4 (75.5 : 37.6 : 26.3 ft.), and contains 643 comfortable seats. For each seat in both halls (1588 + 643 = 2231) there are allowed an average of 13.15 to 13.45 sq. ft. of gross ground area covered by the building. If we compare the net useful area of the principal story (the lower story cannot be considered) with the ground area covered, an addition of over 75 per cent to the net useful area is required.

b. Building not detached on one or more Sides.

1. Rectangular Ground Plan.

131. Girl's School in Hamburg.

The Girl's School of St. John's Convent in Hamburg is represented in Figs. 183 and 184 and was built adjoining neighboring houses on a site with frontage of 141 ft. and average depth of 180.5 ft. The rooms required were class rooms for about 800 girls, singing and drawing rooms, gymnasium, large addience hall, residence of the director, and rooms for several female teachers, which required a building of three stories. From the restricted site of the building, it is obvious that a front wing with two rows of apartments and central corridor would not adequate, (Arts. 124, 116) making it necessary to add a wing extending the entire depth of the land, and consisting of a single row of rooms with side corridor. Local conditions (orientation and good lighting) made the location of this wing on the main axis A B of the building most suitable, thus producing a ground plan of T-form, placing most class rooms on the open and quiet garden front, with the great hall, the residence, and some elementary and seminary classes on the principal front.

With three rows of double desks and comfortable aisles, depth of the class rooms was made 21.7 ft.; those of gymnasium, drawing room, and of class rooms above these and in rear of the main building were 23.0 ft.; that of front elementary class rooms was 20.4. The central corridor between them for direct communication was rather narrow at 12.2 ft., the total depth of front building being fixed at 62.4 ft. Distance from street line being settled by the house adjoining on the right, the great hall was first placed at right angles to chief axis A B. It could then be set back to line of house adjacent on the left, and the entire depth to rear wall of the corridor assumed and a central scheme adopted, for which 131.2 ft. remained after cutting off two class rooms each on at right and left. Since the hall extended through two upper stories, its height was satisfactory.

It was evident that the entrance and main stairway should also be arranged on axis A B, the latter being at intersection (Art. 126) of front building and rear wing. The outlines of the wing were then laid out after width of corridor was fixed at 9.2 ft. and total width at 36.7 ft. To this corridor was added at the rear a stairway and a toilet room for each story, with covered portico before class rooms for use during bad weather. For central corridor of front building, stairways were likewise indispensable, especially in the upper stories. They were placed at each end with light courts and were further lighted by skylights. This was the general arrangement of the building, sufficiently illustrated by plan of passages (Fig. 182) and by plans in Figs. 183 and 184. Arrangement of ground story and subdivision of the class rooms, living rooms, etc., do not require further notice.

For each seat there is allowed about 16.2 sq.ft. ground area covered by the building, including rooms for common use and the residences. If the three stories are taken and the average utilized area be compared with total ground area covered (the hall being counted as a single story), the latter exceeds the former by about 90 per cent.

2. Partially Oblique Ground Form.

132. Palace of Archduke Louis Victor in Vienna.

This usually results from the form of the site, especially when buildings are erected in blocks. This is the case in Palace in Vienna (Figs. 185 to 188). This site was very restricted in both location abd area (15600 sq. ft.) and a further requirement was made that the palace should have external similarity and height with the residence of Von Wertheim, then being constructed on the opposite corner.

To explain the general plan, it is only necessary to mention the **require-**

ments of the programme.

Above the cellar story with its kitchen and store rooms, laundry and bath rooms, a ground story for stables, coach house and servants' rooms was required, then a mezzanine story intended as a part of the living rooms of the Archduke and his household. The first principal story was taken for the social apartments, the salon of the Archduke and the living apartments of the Archduchess, the second principal story containing other living apartments for the household and the servants. The entrance hall, the principal stairway, and the festal salon in the first principal story were designated as the chief objects for dignified architectural treatment. The salon became the starting point. Its location directly on Schwartzenburg Palace, the entrance hall beneath A, the direction of main axis A B, all are naturally indicated. At the right of the festal salon could be placed the dining hall, dtached from the living apartments. The joderate depth of the latter required the same depth of the salon on account of the limited space, but the salon obtained width required for external appearance of the building by the flanking angle bays on the principal facade. The projection of this part of the building was fixed by the internal arrangement and by the different depths of the two halls from the continuous middle wall.

After these principal apartments had been previously fixed, there remained the salon suite of the Archduke and the apartments of the Archduchess on the fronts on Ring St. and on Pestalozzi St. A wing could then be carried along Ring St. facade with a depth of 29.5 ft. and one along Pestalozzi St. 24.6 ft. deep, the obtuse angle being properly adjusted by the circular bay. The plan was thus externally completed. To plan a spacious and beautiful court and a grand and dignified stairway in the remaining internal space was no slight problem. Without injury to general effect, this was solved by placing the staircase at right angles in the corner of the palace, starting on transverse axis of entrance hall, leading through mezzanine story and ending there. According to the limits on the place, a wing 26.3 ft. wide was cut off, and the conservatory was made 21.4 ft. wide on the Ring St. front, with a vestibule 14.1 ft. wide behind the festal salon. A narrower corridor opposite forms the fourth side of the court which is 46.0 ft. long and 36.0 ft. wide, its walls composed of arcades with three and four openings each, and windows for lighting the apartments. That corridor leads to a side staircase placed be-~~hind~~ tween sides of the angle and at apex of the internal triangle produced by irregularity of the site. The remaining space is employed for adding subordinate rooms and a light court at the rear of the adjacent

structure.

This is the general arrangement of the principal story, illustrated by the plan of the passages, Fig. 188. Subdivision in detail proceeds without further difficulty, like the lower story. Of especial interest is the ground story with noble entrance hall, the commencement of the staircase, and the carriage passage from Schwartzenburg Place to Pestalozzi St. The principal facade is shown in Fig. 187 and corresponds to the requirements of the problem. A comparison of the ground area covered with the utilized area is limited to the principal story and an addition of 80 per cent to the latter is required. The limits for these explanations would be exceeded, if the method for designing were discussed further. The way is opened to be pursued in the next Division.

DIVISION IV.

TREATMENT OF EXTERNAL AND INTERNAL ARCHITECTURE.

By Professor Joesph Buhlmann.

Chapter 1. Forms of Facades.

133. General.

The appearance of a building depends on two factors. The first is the form of its entire mass, which primarily impresses itself upon an observer, and at a distance this is alone perceptible. Secondly come the vertical surfaces of these masses, usually only visible near at hand, but which by their subdivision and ornamentation produce the particular impression or individual artistic effect. It will be best to briefly summarize that said in the preceding Division on the first point.

The mass of a building may be united or closed, may be divided in detached masses or be grouped. A closed form produces a simple prismoidal, cylindrical, or pyramidal mass, if the programme proposes a very simple purpose, fulfilled by a single room, or if similarity of required rooms permits them to be combined in a single united form, indicated by reasons of construction and suitability. A grouping of the entire building occurs if the building programme requires a number of rooms, serving for unlike purposes, and which can properly be arranged only in separate buildings. The organic connection of the different rooms requires a combination of the masses into a single architectural whole. By prominence of the chief portion and subordinate annexing of less important rooms in a symmetrical position along a main axis, diversity of such an architectural group produces a united and organic appearance. Since the arrangement of rooms